for ISDN or high-speed data and video services. Whereas the Joint Board has found that the USF should cover the cost of providing voice service, not ISDN or high-speed data services, the models should be modified so that on a wire center or feeder route base, the economic crossover point between fiber and copper should be determined.

Algorithms for determining the economic crossover point have been available for years and they should be incorporated in the models.[7] We believe that such an approach is preferred to the current manner in which sensitivity analysis has been conducted. At times, the models have been used to evaluate the impact of applying different break points. For example, ET&I used BCM2 to examine the impact of changing the crossover point from point.[8] This type of sensitivity analysis only partly captures the engineering economics of the loop because for different wire centers or feeder routes, the optimal crossover point varies. In an urban area, the crossover point may be 9,000 feet, while in a rural area is could be twice that value. Since the models do not permit the user to set the crossover point on a feeder route or wire center basis, the type of sensitivity analysis conducted by ET&I only succeed in a limited way in determining the optimal crossover point.

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[7]See, for example, David Gabel and Mark Kennet, "Estimating the Cost Structure of the Local Telephone Exchange Network," National Regulatory Research Institute (91-16), October 1991, pp. 82-83.

[8]Susan M. Baldwin and Lee L. Selwyn, *Converging on a Cost Proxy Model for Primary Line Basic Residential Service* (Boston: Economics and Technology Inc., August 1996), p. 74.

Cost of Digital Line Carrier Equipment

We are in the process of collecting data from public sources regarding the cost of installing digital line carrier equipment. Based on our initial review of the data, the investment values used in the BCPM are higher than the costs incurred by some small Independent Telephone companies.

The model sponsors provide the following data regarding the cost of deploying digital line carrier:[9]

Digital Carrier Cost Table

Cost for DIGITAL LOOP CARRIER equipment		
Dlc Fiber Size	Fixed Cost	Per Line Cost
	$38,867.00	$92.81
49	$53,577.00	$92.81
121	$84,976.00	$92.81
241	$92,147.00	$92.81
673	$125,120.85	$92.81

[9]BCPM submission to the FCC, January 30, 1997, Attachment 9, p.145. According to the model sponsors, "Fixed cost assumes all installed first costs associated with the placement of DLC systems at both the remote terminal and the central office. The fixed cost includes common equipment, site preparation, right-of-way cost, remote cabinets, commercial power, protection, central office fiber optic terminal (FOT/COT) etc. The Per Line Cost or variable cost is the installed cost of line cards on a per line basis (installed cost of line cards divided by 4 services per line card at the Remote Terminal plus the installed cost of the central office line card (DS1 card) divided by 24 services per card. The default values are average costs reported by the participating LECs then smoothed by removing outliers (very low and very high cost). Ibid., p. 146.

1335	$217,267.85	$92.81

In the following Tables we compare the BCPM investment values with some publicly available data. The first Table is derived from data contained in Mount Horeb Telephone Company's construction expenditure request made to the Wisconsin Public Service Commission on June 9, 1995. The Independent identified the investment at both the remote and host location for fully loaded 48, 120, and 240 electronic equipment-line unit costs. The Table illustrates two points. First, the BCPM estimate is higher than the value identified by Mount Horeb. Furthermore, the cost of the analog units varies depending on the size of the remote site. This variation is not reflected in the BCPM.

Fully-equipped	BCPM	Budgeted	Budgeted analog units
48 Line Unit	$43,321.88	$23,493	$146.19
120 Line Unit	$64,714.20	$42,764	$104.60
240 Line Unit	$107,250.40	$65,392	$87.17

Our second example is also derived from a loan authorization request submitted to the Wisconsin Public Service Commission. On October 18, 1996, Baldwin Telephone requested authorization for fiber-in-the-loop equipment. For the Baldwin central office, the Company indicated that it planned to construct nineteen additional nodes for fiber terminations. The Company's loan application forecasts an expenditure of $682,770 for the remote and central office facilities, while the

BCPM model would predict an investment of $984,074. The difference is due to the fixed cost. The Baldwin application suggests that the per line investment is $120 in the field and $90 in the central office. This sum, $210, is considerably higher than the $92.81 used in the BCPM.

BCPM Switch Curve Developments

The BCPM sponsors report the results of collecting switch investment data from a number of local exchange carriers. The sponsors, relying on work done by Indetec, conclude that the investment in a switch is 216,871 + 225 * number of lines.

The model sponsors report that "investigation of the type of switch showed that the host / remote indicator was not statistically significant" and therefore there is no need to distinguish between the cost of a host and remote.[10] This conclusion suggests a frightening misunderstanding of statistics and network economics. If there were no difference in the cost of using a host or remote switch, suppliers would not opt to use remote switching machines. Remote switching machines do not provide the same functions as a host. For example, they do not provide connections to toll offices, tandems, or multiple local offices. Neither do remote offices have the same ability to support vertical services or process calls. Because of the limited capabilities of remotes, they cost

[10] BCPM submission to the FCC, January 30, 1997, Attachment 4, p.38.

considerably less than a host-switching machine. The Table below illustrates this point. While we recognize that the cost data is ten years old, we believe that similar cost relationships exist today.

Fixed Investment Per Switch: 1986	
5ESS	1,280,000
5ESS Remote	164,000
DMS-100	646,000
DMS-100 Remote	149,000
Dms-10	159,968
Source: New England Telephone, Massachusetts Incremental Cost Study, April 1986, Book 1 of 3.	

The data below shows that the fixed cost of a remote is significantly less than that of a host switch. Since the type of cost results contained on this table are reflected in the raw data used by Indetec, it was improper for them to test a hypothesis that the fixed cost of a remote and host switch is equal. Since this cost difference is reflected in the SCIS equations, there is no doubt that this difference exists and this fact should have been reflected in the regression. Furthermore, since the fixed and line cost of a switch varies between vendors, the modeling should have also distinguished between the fixed and line cost of the different vendor's switches.

We are also concerned about the sponsors' decision to exclude data from a company because they do not use Bellcore's SCIS model. The model sponsors indicate that they were concerned that if both SCIS and non-SCIS data were used in the analysis, "the comparability of the data" would be in doubt.[11] It is common knowledge that US WEST does not use SCIS.[12] We would have anticipated that both SCIS and US WEST's model would provide similar results. But apparently they do not and this raises the question: why was it appropriate to use data from SCIS rather than data from US WEST's switching model.

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[11]BCPM submission to the FCC, January 30, 1997, Attachment 4, p.37.

[12]FCC ONA Order, CC Docket 89-79.

The reasonableness of the BCPM numbers can also be evaluated by comparing the estimates with data contained in the two loans discussed above.

Mount Horeb Telephone, June 1995[13]			
Host	**Units**	**Unit Cost**	**Total**
Startup cost (including power and testing capabilities)			$185,000
Basic Line Equipment	5,487	210	1,152,270
LAMA/BMC	1	60,000	60,000
Fire Protection System	1	9,000	9,000
Remote	**Units**	**Unit Cost**	**Total**
Startup cost (including power and testing capabilities)			80,000
Basic Line Equipment	600	230	13,800
Fire Protection System	1	6,000	6,000

The per line cost for the host and remote are in same range as reported by BCPM, $225 per line. On the other hand, the getting started costs are considerably less for both the host and remote. The Table also illustrates two other points. First, the getting started cost of a remote is still considerably less than the getting start cost of a host. This is due, in part, to the second point illustrated by the Table. The remote does not carrying out billing functions. The

[13]Mount Horeb Company to the Public Service Commission of Wisconsin, June 9, 1995.

LAMA/BMC functionality resides in the host, and not the remote, and this is one factor that makes the host more expensive.

Baldwin Telephone Company: May 1996			
Host	**Units**	**Unit Cost**	**Total**
Startup			$250,000
Lines	2,970	135	$400,950
Digital Trunks (DS1)	12	5,300	63,600
Remote Interfaces	8	4,100	32,800
SS7	1	40,000	40,000
CLASS	1	53,000	53,000
LAMA w/ Remote Polling	1	55,000	55,000
Custom Calling	1	15,000	15,000
Centrex Features	1	30,000	30,000
TR-303 Multivendor Interface	1	65,000	65,000
Power	1	22,500	22,500
Remote	**Units**	**Unit Cost**	**Total**
Sonet RSCS Startup			124,000
Additional CLCE	1	29,850	29,850
Lines	1,320	81	106,920
Power			17,000
Spares			51,700

For the host office, the sum of the items on the Table is $1,027,850, approximately 20% higher than the value predicted by BCPM, $885,121.[14] For the remote office, the opposite occurs. The data on the Table sums to $329,470, while BCPM would predict $513,871. For this Company, the error in the host and remote offset one another and the total investment predicted by BCPM, $1,398,992, is quite close to the Company's forecasted value, $1,357,320.

The data from the Baldwin Telephone Company illustrates two points. Again, it is clear that the getting started cost of the remote is less than the getting started cost of the host. Second, we see a significant variation in the incremental cost of a line. For these two offices, the incremental cost per line is significantly less than the amount predicated by BCPM.

Ben Johnson Associates, Inc.'s Telecom Economic Cost Model

Model Structure

Ben Johnson Associates sponsored a new cost model at the January 1997 FCC's workshop. We have reviewed the model and conclude that the model should not be used at this time to estimate the cost of providing universal service.

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[14]Baldwin Telephone Company to Wisconsin Public Service Commission, May 9, 1996, Exhibit E. The application also includes data on the cost of ISDN PRI and the advanced intelligent network. We have excluded these items since our focus is on the cost of providing POTS and currently available vertical services.

The model, the Telecom Economic Cost Model (TECM), does offer one significant improvement over the other models. The TECM has a very nice user interface that is handy for changing the default values of the inputs. On a wire center basis, a user can modify the value of all inputs to the model. The method for changeling the value of the data is easy to learn and therefore it is feasible to easily conduct sensitivity tests at the wire center level.

Paradoxically this advantage is also one of the model's drawbacks. The FCC needs a model that can estimate the cost of providing universal service throughout the nation. Conducting analysis at the wire center level makes sense if the user of the model has specific knowledge of the area. Typically though it will not be possible to find individuals who know the special nuances of the different wire centers in a State, much less the entire country. Hence it is impractical to use the model on a State, much less a National level, because of the lack of data.[15] While this information problem can be circumscribed by relying on the default values in the model, as we discuss below, we do not feel comfortable with the model's default values.[16]

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[15]The Pennsylvania Public Service Commission recently concluded that in part because of the large data entry requirements of the TECM, the BCM2 and Hatfield models were more "user-friendly" than the Ben Johnson's model. *In RE: Formal Investigation to Examine and Establish Updated Universal Service Principles and Policies for Telecommunications Services in the Commonwealth,* Docket No. I-00940035, Order Entered January 28, 1997, p. 62.

[16]At the workshop, Ben Johnson also claimed that a major advantage of the model was the ability to conduct analysis of how changes in market share affected the cost of production. Similar analysis can be conducted with the other models by varying the

TECM Data Inputs

The comments regarding TECM are based on our evaluation of the model that was presented at the January workshops. Whereas we have only recently received the revised version of the model, our comments do not reflect the modifications that were recently reported to the FCC.[17]

Our preliminary review of the TECM identified one important improvement over the existing models. TECM provides some valuable data on the cost of using a switching machine in a rural area. Independents often use switching machines that are not manufactured by the largest manufacturers in the industry. TECM provides an estimate for the cost of using the REDCOM switch. For offices with less than 400 lines, the program assumes that the REDCOM switch is used. We concur with Ben Johnson Associates that this type of technology is used by the Independents at small switching offices and should be included in the model eventually adopted by the FCC.[18]

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number of subscribers. This type of market analysis is easier with TELECOM but not to such an extent to justify substituting TELECOM for the other models.

[17]"Comments of the New Jersey Division of the Ratepayer Advocate Concerning Improvements to the Telecom Economic Cost Model," CC Docket No. 96-45, January 31, 1997.

[18]We are seeking additional information on the extent to which the cost assumptions built into the model are reflective of what carriers typically pay for the Redcom switch ($12,000 getting started investment and $180 per line). The information we have to date suggests that these values are too low.

On the other hand, TECM lacks the richness of both the BCPM and HM in terms of working with customer locations. Both the BCPM and HM use census data to identify the distribution of customers around each wire center. TECM does not work with the census data; rather it obtains from BCPM the average loop length for each of the feeder routes in a wire center. The average loop length, by definition, does not provide any information regarding the distribution of customers around the average. Whereas the cost of service can be quite sensitive to the distribution of customers, the use of the average loop length makes the model unacceptable for establishing the size of the national fund.

There are other data problems with the model. We note below a few problems that we identified during our review:

A. The default assumptions regarding the number of hours for installing different types of cables do not seem reasonable. The model developers have established default values of 13 and 55 hours of installation labor respectively for 1,000 feet of 50 pair buried and aerial cable.[19] While there are exceptions, generally it takes less time to install aerial than buried cable.

B. The model does not properly reflect the manner in which a telephone network is designed. The model has only contains an input for one size cable, and does not include load coils. This unigauge architecture can not be

[19]File bjafcctx.xls, folder technical, rows 241 through 259.

used for serve customers that are located more than 18,000 feet from a central office. For customers located more than 18,000 feet from a central office, different gauge copper and load coils are required.

C. The model implicitly assumes that in densely populated areas, the cost of installation per sheath foot declines. TECM assumes that second and subsequent cables installed a feeder route require 100% less engineering time and that placement costs are reduced by 70%.[20] We do not concur that if a second cable is installed along the same route, the incremental engineering hours is zero. Second cables are often required in densely populated markets and therefore the engineering effort may increase more than proportionately because of the greater likelihood of obstacles. Field engineers have to identify obstacles before the plant is installed and this will entail more effort in densely populated markets. Due to these obstacles, we also feel uncomfortable with the assumption that in densely populated areas, the trenching costs would be reduced by 70% for the second cable. Instead, we concur with both the developers of the BCPM and the HM that the sheath installation costs are highest in densely populated markets. The TECM model, on the other hand, assumes that the installation costs are lowest in the most densely populated market.

[20]File bjafcctx.xls, folder technical, rows 170 to 172.

D. In certain places the model is not well documented. The model calculates loop costs using undefined constants that are not defined. For example, in the folder netchar, cells c103 through c110, there is a value 45. The value of 45 is an input in the folder miscdata (cell h9). There is no documentation explaining how the value was derived (neither is there a heading for the cells c103 through c110).

E. Also the modeling of loop costs is simplistic in that it appears to always assume the same number of feeder segments regardless of how customers are distributed (see user documentation, page 39, first full paragraph--discussion of segments a through f, and folder netchar rows 104 through 110). The model also has some undocumented factors (see the value .26 in cell c130 of folder netchar, and the value .48 in same folder, cell l38 and h38). Note that in netchar, rows 104 through 110, many of these numbers are multiples of 4. The use of multiples of four is an outgrowth of the sponsor's assumption that the territory is a big square, which is divided into a series of smaller squares. These smaller squares are apparently the basic building block for the cost model. The Pennsylvania

Commission recently concluded that the assumption of a square wire center "is not reasonable when matched to actual customer location data."[21]

F. Schedule 2 of the data submitted along with the filing shows surprising little variation in the end office switching investment per line (see the last column). For example, the first line, ablntxorr has an investment per line of $207. The third line, abrytxgis, has an investment of $243 per line. The number of customers on these two switches is 18974 and 1644 respectively (file swbtxdat.xls). We would expect to see a greater difference in the investment per line for such a large difference in the number of subscribers.

G. The cost of installing conduit does not vary by population density (see structCost, rows 17 through 21). On the other hand, the conduit cost per foot, $31, is not unreasonable for a national average value.

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[21] In RE: Formal Investigation to Examine and Establish Updated Universal Service Principles and Policies for Telecommunications Services in the Commonwealth, Docket No. I-00940035, Order Entered January 28, 1997, p. 74.

Manholes

There has been some disagreement among the model sponsors regarding the cost of manholes. We do find that the cost of manholes vary by soil type. The Rural Electrical Administration recommends that for fluid soil, a different type of manhole, as well as thicker walls.[22]

Sharing of Poles

In a recent National Regulatory Research Monograph, "Improving Proxy Cost Models for Use in Funding Universal Service," David Gabel proposed a method for taking into account conduit and pole investment based on data contained in the local exchange company records.[23] The proposal resulted in a loading of $2.51 and $12.66 per foot that would be added as a loader for every sheath foot of aerial and underground cable respectively. These loading factors implicitly reflect the sharing of structures because to the extent that another utility has made investments in conduits and poles, these investments were not included in the formulas that were used to derive these values.

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[22]United States Department of Agriculture, Specifications and Drawings for Conduit and Manhole Construction, REA Bulletin 345-151, May 25, 1989, pp. 12-13.

[23]NRRI Publication 96-34, pp.22-25.

Both the BCPM and HM use a different method for estimating structural investments. The models include the full cost of the structures and then allocate a portion of the investment to non-telephone utility use, such as electric power. In our review of Rural Utility Service Applications, we did see some, but not many, reference to the sharing of structures.[24] For example, Delta County Tele-Comm Inc. of Paonia, Colorado provided the following data:

Outside plant construction utilizes joint use facilities when the best interests of the Telephone Company are served. Where this occurs, Delta County Tele-Comm, Inc. (DCTC) Has an agreement with Delta-Montrose Electric Association (DMEA) which covers the joint use of facilities. The current summary of such (for 1989) is as follows:[25]

Description	**Poles**	**$/Pole**	**Total**
DCTC attachments on DMEA owned poles	*4,332*	*5.50*	*$23,826*
DMEA attachments on DCTC owned poles	*42*	*7.00*	*(294)*
Difference in favor of DMEA			*$23,532*

[24]The frequency of remarks is not indicative of the extent to which structures are shared. There is no requirement that the loan applicant address the extent to which structures are shared.

[25]Area Coverage Survey/Loan Design, January 24, 1992, p. 16.

Note that for this company, there is much greater likelihood that a pole is owned by the electric company, rather than the telephone company, will be shared. The formula that David Gabel used to derive the values reported above, $2.51 and $12.66 per foot effectively assume that there is an equal likelihood that either company will own the facilitity. For this company, that is a poor assumption to make. Hence, while the $2.51 and $12.66 can be used as default values, ideally the cost of the structures would be explicitly modeled and a portion of the structural investment would be allocated to telephone operations based on the actual operations of the utilities.

The Delta County narrative does illustrate that poles are often shared.

The use of publicly available RUS data provides costs results that likely fall in-between the BCPM and Hatfield approaches. The BCPM model assumes higher installation costs than the values reflected in the RUS data. The Hatfield model assumes a greater degree of trench sharing that likely occurs in the RUS installations. Regardless, the data reflects that actual costs of installations based on publicly available data.

The Cost of Installing Cables

One of the primary differences between the HM and BCPM is modeling the extent to which the cost of installing cables vary by soil type. In this section of the paper, we use publicly available data to evaluate the extent to which installation costs vary by terrain. The data from this analysis was obtained from various rural utility service loan applications.

As shown on the following Table, the cost of installing buried cable does vary by terrain. The data is based on an analysis of installing a foot of 24 gauge cable. The estimates include both material and installation costs (a mix of trenching and plowing). The marginal cost column indicates the cost of installing one additional pair foot.

The parameter estimates can be used as follows. The equipped, furnished, and installed cost (EF&I) of a 25 pair cable in normal soil would be 1.083051 + 25 * .013857 = $1.43. The EF&I of a foot of 50 pair cable installed in hard rock would be 1.441161 + 50 * 0.014011 = $2.14.

	Buried Copper		
	Fixed Investment Per Foot	Marginal Investment Per Pair	R2
Hard Rock	**1.441161**	**0.014011**	**0.938962**
Soft Rock	1.312612	0.016003	**0.907521**
Normal Soil	1.083051	0.013857	**0.948015**

The following table provides the results for buried fiber cable.

Buried Fiber

Soil Type	Fixed Investment Per Foot	Marginal Investment per Strand	R2
Hard Rock	**1.324599**	**0.086018**	**0.864590**
Soft Rock	**0.689814**	**0.110358**	**0.709440**
Normal	**0.875690**	**0.095843**	**0.605641**

The data from this table indicate that the EF&I per foot of a 12 strand fiber cable installed in hard rock is 1.324599 + 12 * .086018 = $2.36.

In our subsequent submission to the Staff we will include additional statistical information (e.g. standard errors of coefficients, sample size). In addition, we will attempt to provide data for aerial and underground cable, marshy terrain, and distinguish between the cost of installing cable in areas that have and have not been previously wired for telephone service.

BEFORE THE FEDERAL COMMUNICATIONS COMMISSION

WASHINGTON, D.C. 20554

In the Matter of	)	
	)	CC Docket No. 96-45
Federal-State Joint Board on	)	
Universal Service	)	
	)	

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that a true and correct copy of the foregoing Commission Comments have been furnished to the parties on the attached service list this 14th day of February, 1997.

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